Review Article

Lean meat and heart health

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The general health message to the public about meat consumption is both confusing and misleading. It is stated that meat is not good for health because meat is rich in fat and cholesterol and high intakes are associated with increased blood cholesterol levels and coronary heart disease (CHD). This paper reviewed 54 studies from the literature in relation to red meat consumption and CHD risk factors. Substantial evidence from recent studies shows that lean red meat trimmed of visible fat does not raise total blood cholesterol and LDL-cholesterol levels. Dietary intake of total and saturated fat mainly comes from fast foods, snack foods, oils, spreads, other processed foods and the visible fat of meat, rather than lean meat. In fact, lean red meat is low in saturated fat, and if consumed in a diet low in SFA is associated with reductions in LDL-cholesterol in both healthy and hypercholesterolemia subjects. Lean red meat consumption has no effect on in vivo and ex vivo production of thromboxane and prostacyclin or the activity of haemostatic factors. Lean red meat is also a good source of protein, omega-3 fatty acids, vitamin B12, niacin, zinc and iron. In conclusion, lean red meat, trimmed of visible fat, which is consumed in a diet low in saturated fat does not increase cardiovascular risk factors (plasma cholesterol levels or thrombotic risk factors).

Key Words: nuts, meat, heart disease, CHD risk factors, LDL cholesterol, saturated fat, polyunsaturated fatty acids.

Introduction

A balanced and broadly varied dietary intake plays a critical role in human health. Human and pre-human diet history shows that for a period of at least two million years the human ancestral line had been consuming increasing quantities of meat. During that time, evolutionary selection was in action, adapting our genetic make up and hence our physiological features to a diet high in lean meat.1 This meat was wild game meat, low in total and saturated fat (SFA) and relatively rich in polyunsaturated fatty acids (PUFA).2

Since 1984, there have been a number of epidemiological and prospective studies that have suggested that red meat consumption is associated with increased risk of coronary heart disease (CHD).3,4 Furthermore, vegetarians living in industrialised societies such as the Seventh Day Adventists have a low incidence of CHD.5 In addition, the individual SFA intakes (lauric, myristic, palmitic and stearic acid) showed a high correlation with mortality from CHD in the Nurses’ Health Study6 and the Seven Countries Study.7 In the Nurses’ Health Study from USA, the dietary intake of stearic acid, with beef as a primary source (as main dish, mixed dish, sandwich and hamburgers) was reported to increase the risk of CHD even more than did myristic, palmitic and lauric acids.8 Cross sectional studies have shown that omnivores have a significantly higher intake of total fat and SFA which was associated with increased plasma/serum total cholesterol (TC) and low density lipoprotein cholesterol (LDL-C) compared with vegetarians.9,10 After further analysis of the fat sources, based on food frequency questionnaires, it was found that only 8% of daily fat intake was gained from meat cuts, and 12% from meat dishes and meat products. Hidden fats in fast foods, snack foods and other processed food were the primary sources of dietary SFA intake.10

It is well known that meat fat from all animals is rich in SFA, and in order to promote reductions in dietary total and SFA intakes, many health professionals have encouraged people to reduce their consumption of meat, a message which may have contributed to the decline in meat consumption over the past three decades.11 For example, replacing red meat with white meat might have benefits in relation to lipoprotein lipids, since red meat was regarded to be higher in SFA and lower in PUFA compared with white meat.12 There is confusion amongst consumers about the impact of lean meat and visible fat on human health, because it is commonly, but incorrectly thought that lean meat will have the same SFA content as the visible fat of meat.

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**Table 1. Fatty acid profiles of lean and visible fat of meats (mg/100g)**

<table>
<thead>
<tr>
<th>Meat</th>
<th>SFA</th>
<th>MUFA</th>
<th>PUFA</th>
<th>Visible fat</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lean lamb</td>
<td>388 ± 56</td>
<td>393 ± 89</td>
<td>151 ± 19</td>
<td>40 ± 10</td>
</tr>
<tr>
<td>Fat lamb</td>
<td>1483 ± 247</td>
<td>1443 ± 335</td>
<td>333 ± 92</td>
<td>81 ± 22</td>
</tr>
<tr>
<td>Lean chicken</td>
<td>571 ± 625</td>
<td>651 ± 878</td>
<td>362 ± 109</td>
<td>86 ± 65</td>
</tr>
<tr>
<td>Fat chicken</td>
<td>744 ± 90</td>
<td>883 ± 186</td>
<td>358 ± 16</td>
<td>40 ± 10</td>
</tr>
<tr>
<td>Pork</td>
<td>306 ± 90</td>
<td>332 ± 66</td>
<td>282 ± 46</td>
<td>55 ± 10</td>
</tr>
<tr>
<td>Fat pork</td>
<td>254 ± 35</td>
<td>252 ± 42</td>
<td>277 ± 38</td>
<td>40 ± 10</td>
</tr>
<tr>
<td>Beef</td>
<td>384 ± 56</td>
<td>393 ± 89</td>
<td>151 ± 19</td>
<td>40 ± 10</td>
</tr>
<tr>
<td>Fat beef</td>
<td>1483 ± 247</td>
<td>1443 ± 335</td>
<td>333 ± 92</td>
<td>81 ± 22</td>
</tr>
</tbody>
</table>

**Does a diet rich in lean red meat increase plasma cholesterol?**

A: Yes, in the first study, lean red meat was consumed and a significant increase in plasma total cholesterol and LDL-C levels were observed. In the second study, a diet rich in lean red meat and fish was consumed and the increase in plasma cholesterol levels was smaller, although still significant.

**Does a diet rich in lean red meat increase plasma triglycerides?**

A: Yes, in both studies, a diet rich in lean red meat led to a significant increase in plasma triglyceride levels.

**Is lean red meat rich in saturated fat?**

A: Yes, lean red meat contains more saturated fat (SFA) compared to fat red meat.

**Is lean red meat rich in monounsaturated fat?**

A: Yes, lean red meat contains more monounsaturated fat (MUFA) compared to fat red meat.

**Is lean red meat rich in polyunsaturated fat?**

A: Yes, lean red meat contains more polyunsaturated fat (PUFA) compared to fat red meat.

**Is lean red meat a good source of long-chain omega-3 polyunsaturated fatty acids?**

A: No, lean red meat is not a good source of long-chain omega-3 polyunsaturated fatty acids (LCPUFA).

**Is lean red meat a good source of short-chain omega-3 polyunsaturated fatty acids?**

A: Yes, lean red meat is a good source of short-chain omega-3 polyunsaturated fatty acids (SCPUFA).

**Is lean red meat a good source of short-chain omega-6 polyunsaturated fatty acids?**

A: Yes, lean red meat is a good source of short-chain omega-6 polyunsaturated fatty acids (SCPUFA).

**Is lean red meat a good source of medium-chain omega-6 polyunsaturated fatty acids?**

A: No, lean red meat is not a good source of medium-chain omega-6 polyunsaturated fatty acids (MCPUFA).

**Does a diet rich in lean red meat increase heart disease risk?**

A: Yes, in both studies, a diet rich in lean red meat was associated with an increased risk of heart disease.

**Is lean red meat rich in vitamin E?**

A: Yes, lean red meat is a good source of vitamin E.

**Is lean red meat rich in vitamin D?**

A: No, lean red meat is not a good source of vitamin D.

**Is lean red meat rich in vitamin A?**

A: Yes, lean red meat is a good source of vitamin A.

**Is lean red meat rich in folate?**

A: Yes, lean red meat is a good source of folate.

**Is lean red meat rich in iron?**

A: Yes, lean red meat is a good source of iron.

**Is lean red meat rich in zinc?**

A: Yes, lean red meat is a good source of zinc.

**Is lean red meat rich in copper?**

A: Yes, lean red meat is a good source of copper.

**Is lean red meat rich in selenium?**

A: Yes, lean red meat is a good source of selenium.

**Is lean red meat rich in potassium?**

A: Yes, lean red meat is a good source of potassium.

**Is lean red meat rich in magnesium?**

A: Yes, lean red meat is a good source of magnesium.

**Is lean red meat rich in phosphorus?**

A: Yes, lean red meat is a good source of phosphorus.

**Is lean red meat rich in calcium?**

A: Yes, lean red meat is a good source of calcium.

**Is lean red meat rich in sodium?**

A: No, lean red meat is not a good source of sodium.
LDL-C concentrations. The HDL-C concentrations were significantly reduced for both diets, but the LDL-C: HDL-C ratio was significantly lower in the modest fat diet compared with the very low fat diet. These results indicate diets rich in fat-trimmed lean beef and low in SFA (not total fat) were effective in reducing plasma/serum TC and LDL-C levels. The SFA content of the two dietary regimes were 4.2 and 6.7% of energy compared with the subjects usual diet SFA intake of 15.1% energy.

(b) Studies using mixed meat (chicken, beef and pork): Effect of mixed meat and meat products with different amounts of animal fat on plasma and lipoprotein lipids have been investigated in 15 free-living hyperlipidaemic men with a mean age of 49.9 years. The study comprised a 4-week reference period (diet A, typical of the average British diet, 42% energy from fat with 21% SFA), followed by two four-week experimental dietary periods (diet B, 35% energy from fat with 14% SFA, and diet C, 27% energy from fat with 8% SFA with a fibre supplement). Daily consumption of meat and meat products was the same in each experimental dietary period (180 g/day, 20 g cooked and 160 g raw weight). In this study the mixture of meat and meat products included carcase meat, offal, bacon cooked meats, canned meats, sausages, meat pies and other meat products. The fat content of meat and meat products was 16% for diet A, and 8.5% for diets B and diet C. Compared with diet A, the plasma concentrations of TC and LDL-C fell by 8.6% and 11% in diet B, by 18.5% and 23.8% in diet C. TAG, HDL-C and BMI did not change appreciably during the study. Based on these results the authors suggested that it was possible to reduce plasma cholesterol levels by reducing dietary fat (animal fat) rather than removing meat from the diet.

(c) Comparison of red meat and white meat: In a recent crossover study, 18 hypercholesterolemic men aged 21–73 y were assigned to either a lean beef or lean fish or poultry diet with 30% of energy from fat, for at least 26 days each with a 6 week washout period. The three experimental diets reduced plasma TC and LDL-C by 5-9% compared with baseline. No significant differences between the 3 experimental diets were found in these lipid variables. In a 13-week dietary intervention study, 38 free-living hypercholesterolemic men completed two test diets for 5 weeks each. The test diets contained either 85g of cooked beef (8% fat) or 85g of cooked chicken (7% fat) with 7% to 8% of energy from SFA. All food was supplied during the study period. Plasma concentrations of TC and LDL-C were significantly reduced by 7.6% and 9% on the beef diet, by 10.2% and 11% on the chicken diet, respectively. There were no significant differences between the beef and chicken diets on concentrations of plasma TC, HDL-C, TAG, and LDL-C. The plasma TAG concentrations did not change for either test diet groups. In another study, 191 hypercholesterolemic subjects (107 male, 84 female) were instructed to consume at least 80% of their meat in the form of lean red meat or lean white meat. Fasting serum lipid levels were assessed at 4, 12, 20, 28, and 36 weeks after commencement of the study. There were no significant differences between lean red meat and lean white meat phases on serum concentrations of TC, LDL-C, HDL-C and TAG at the end of 36 weeks randomisation. Compared with baseline, both the lean red meat and lean white meat diet groups resulted in a nearly identical reduction in TC by 1% and LDL-C by 2%, and increase in HDL-C by 2%. TAG concentrations remained similar to baseline values. These results suggested that lean red meat (beef, veal, and pork) and lean white meat (chicken and fish) had similar effects on plasma/serum concentrations of TC, LDL-C, HDL-C and TAG.

(d) Lean red meat versus soybean products: It has long been recognised that consumption of soy products reduces blood cholesterol levels. The effect of lean red meat versus soybean products on plasma and lipoprotein lipids in healthy and overweight individuals has been compared in two recent studies. In the first study, 36 women, mostly overweight or obese with BMI 32.4 ± 5.2 kg/m², aged 30 to 61 years were assigned non-randomly to either the red meat group (N=19) or soybean group (N=17) for 16 weeks. Both diets were equienergetic (1500 kcal) designed to lead to weight loss. In the red meat diet, subjects consumed lean beef 150g/day at least 5 days per week and they consumed either fish or non-soy legumes for the 2 remaining days (23% of energy from fat with 6.4% SFA). In the soybean diet, subjects were encouraged to consume soy protein (130g per day dried soy bean) at least 5 days per week, and chicken, fish and other legumes for the remaining days (22% of energy from fat with 4.2% SFA). There were body weight reductions of 7.8kg and 7.6kg for the lean meat diet and soybean diet, respectively, at the end of the 16 weeks compared with baseline. Compared with baseline, the concentrations of TC were significantly decreased by 15% for the lean meat diet group and 9% for the soybean diet group, LDL-C by 16% and 10%, and TAG by 13% and 18% at the end of the 16 weeks, respectively. In other words, lean meat and soybean diets had a parallel effect on reduction of plasma TC, LDL-C and TAG. The second study was a randomised crossover dietary intervention study, 42 free-living healthy males aged 35-62y participated in the study. One diet contained lean beef (150g/d) and the other diet contained 290 g/d tofu. The two diets were similar in energy, protein, macronutrients and fibre. Study length was one month for each diet and in between diets subjects resumed their usual diets for 2 weeks as a wash-out period. The TC, HDL-C and TAG were significantly lower in the tofu diet compared with the lean beef diet. Compared with baseline, HDL-C was significantly increased and the LDL-C:HDL-C ratio was significantly decreased in the lean beef diet, but there were no significant changes in the tofu diet. There were no significant differences in the LDL-C: HDL-C ratios between the two diets. These results showed that lean beef and soybean-based diets had equal beneficial effects on plasma/serum and lipoprotein lipids, and body weight reduction.

In summary, these studies showed that the visible fat of meat, rather than the lean meat increased serum cholesterol concentrations. Diets rich in fat-trimmed lean beef and low in saturated fat, not total fat, were effective in reducing plasma/serum TC and LDL-C levels. Lean
in 13 healthy and non-smoking men aged 35 ± 12 years. Each subject was randomly assigned to either the stearic acid diet which comprised 35% hydrogenated canola oil and 65% monounsaturated sunflower oil (stearic acid intake of 19.4 ± 4.5 g/day/head) or the palmitic acid diet which comprised of 50% palm stearane and 50% monounsaturated sunflower oil (palmitic acid intake of 22.5 ± 5.3 g/day/head) for 4 weeks with a 7 week washout period between the two dietary periods. The diets consisted of approximately 30% of energy as fat. Collagen and ADP-induced ex vivo platelet aggregation, mean platelet volume and coagulation factor VII activity were significantly decreased at the end of the stearic acid diet compared with the palmitic acid diet.

Effect of lean red meat (150 g/day/head) and tofu (290 g/day/head) on plasma factor VII activity and fibrinogen concentration have been studied in 45 healthy men aged 35 to 62 years. Subjects were randomly assigned to the lean meat or tofu diet for one month. Subjects consumed their usual diet for two weeks as a “washout period”, and then consumed the second diet for another month. There was no significant difference between the lean meat and tofu diet on plasma factor VII activity and fibrinogen concentration. This result indicates that lean red meat does not cause an increase in coagulation factors (plasma factor VII coagulant activity and fibrinogen concentration).27

Is lean red meat a significant source of n-3 PUFA?

Lean red meat contains α-linolenic acid (18:3n-3), eicosa-pentaenoic acid (EPA, 20:5n-3), docosapentaenoic acid (DPA, 22:5n-3) and docosahexaenoic acid (DHA, 22:6n-3), however, the long chain (LC) n-3 PUFA (20 and 22 carbon n-3 PUFA) are not found in visible fat of meats. The predominant LC n-3 PUFA in lean meat is 22:5n-3, with the total LC n-3 PUFA content is approximately 60 mg/100 g for lean beef and 120 mg/100 g for lean lamb.43

Effect of ingestion of a diet rich in lean beef on the fatty acid composition of plasma PL have been investigated.33 Firstly thirty-three healthy free-living volunteers (16 male, 17 female) aged between 22 to 66 years consumed 300g raw lean beef with no added other fat daily for 2 weeks. Plasma PL composition of 20:5n-3 and 22:5n-3 was significantly increased at endpoint compared with usual diet. Then subjects were divided into three dietary groups with same amount of lean beef, but by an increase in the dietary fat by 10% each week for the further two weeks. The added fat was comprised of beef fat, or olive oil or safflower oil. Lean beef plus beef fat and lean beef plus olive oil were associated with significant increases in plasma PL composition of 20:5n-3 and 22:5n-3. In contrast, lean beef plus safflower oil (>75% of 18:2n-6) resulted a significant decrease in 20:5n-3 and increase in 22:5n-3. Dietary 18:2n-6 intake inhibits EPA incorporation from dietary fish-oil supplements and from dietary meat.4,45 The order of potency in raising platelet PL EPA level was greatest with fish consumption or fish oil supplementation, moderate with lean red meat or linseed oil and least effective with canola oil.46 The content of serum PL 20:5n-3, 22:5n-3 and 22:6n-3 and platelet PL 20:5n-3 and 22:6n-3 significantly increased after 2 weeks of a lean beef diet (351 ± 104 g per day) and an Atlantic salmon diet (133 ± 52 g per day) in 29 healthy adults (14 men, 15 women, mean age 34.8 years) compared with baseline.36 These results indicate that lean red meat does improve the n-3 PUFA status in humans, and dietary 18:2n-6 inhibits the incorporation of dietary 20:5n-3. While the amounts of LC n-3 PUFA in lean meat are not as high as in fish, it has been reported that red meat contributes 20% of LC n-3 PUFA in Australian adults based on the 1995 Australian Nutrition Survey.47

These studies showed that lean red meat consumption does not cause an increased thrombotic tendency in relation to platelet aggregability, mean platelet volume, eicosanoid biosynthesis, plasma factor VII coagulant activity and fibrinogen concentration. In addition, lean meat raises levels of LC n-3 PUFA in plasma and platelets, fatty acids which have been reported to be of potential beneficial effects on CVD prevention.

Red meat improves vitamin B12 and homocysteine status

Hyperhomocysteinaemia is an important independent risk factor for cardiovascular disease. Homocysteine can be in vivo metabolised to cysteine and remethylated to methionine, later involves the enzymatic transfer of a methyl group from 5-methyltetrahydrofolate (5-methylTHF) to homocysteine with vitamin B12 (methylcobalamin) as a coenzyme. Vitamin B12 deficiency might cause an accumulation of homocysteine, leading to a hyperhomocysteinaemia. It has been reported that meat consumption was significantly positively correlated with dietary intake of vitamin B12 based on 24-hour dietary recalls in a cross sectional study in 504 aged 19 to 28 years omnivores.50 Serum vitamin B12 concentration was significantly lower in vegetarians compared with omnivores,50,51 because vegetarians, especially vegans can only gain limited vitamin B12 from vegetables, soy and yeast. The main dietary sources of vitamin B12 include lean meat, seafood, egg yolks, milk and dairy products.52 In a cross sectional study which involved 18 vegans, 43 lactoovo vegetarians, 60 moderate meat eaters (<285 g/day) and 18 high meat eaters, it was found that serum vitamin B12 concentration was significantly negatively correlated with plasma homocysteine concentrations.53 These results showed that dietary meat is a primary source of vitamin B12 and is positively associated with plasma vitamin B12 concentration and negatively associated with plasma homocysteine levels. Lean meat is also a good source of protein, zinc and iron.1

Conclusion

Dietary intervention and cross-sectional studies showed that visible fat trimmed lean red meat does not raise blood cholesterol and LDL-cholesterol levels, and does not change thrombotic risk factors such as thromboxane and prostacyclin production, platelet function and haemostatic factors. In fact, low SFA diets containing lean red meat are associated with a reduction of LDL-cholesterol levels in both subjects with hypercholesterolemia and healthy subjects. Lean red meat is also a good source of protein, omega-3 fatty acids, vitamin B12, niacin, zinc and iron.